US007780731B2

(12) United States Patent
Marnay et al.

(10) Patent No.: US 7,780,731 B2
(45) Date of Patent: Aug. 24, 2010

(54) **INTERVERTEBRAL IMPLANT**

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(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 1137 days.

(21) Appl. No.: **10/996,797**

(22) Filed: **Nov. 26, 2004**

(65) **Prior Publication Data**

US 2006/0116769 A1 Jun. 1, 2006

(51) **Int. Cl.**
A61F 2/44 (2006.01)

(52) **U.S. Cl.** **623/17.11**

(58) **Field of Classification Search** 623/17.11–17.16
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

4,759,766 A 7/1988 Buettner-Janz et al.
4,772,287 A 9/1988 Ray et al.
5,314,477 A 5/1994 Marnay
5,397,364 A 3/1995 Kozak et al.
5,401,269 A * 3/1995 Buttner-Janz et al. 623/17.15
5,507,816 A 4/1996 Bullivant
6,315,797 B1 11/2001 Middleton
6,368,350 B1 4/2002 Erickson et al.
6,428,544 B1 * 8/2002 Ralph et al. 606/99
6,533,817 B1 * 3/2003 Norton et al. 623/17.16
6,607,558 B2 8/2003 Kuras
6,626,943 B2 9/2003 Eberlein et al.
6,645,248 B2 11/2003 Casutt
6,656,224 B2 12/2003 Middleton
6,676,703 B2 1/2004 Biscup
6,682,562 B2 1/2004 Viart et al.
7,503,934 B2 3/2009 Eisermann et al.
2002/0128715 A1 9/2002 Bryan et al.
2002/0156528 A1 10/2002 Gau
2003/0135277 A1 7/2003 Bryan et al.
2003/0135278 A1 7/2003 Eckman
2003/0144736 A1 7/2003 Sennett
2003/0176922 A1 9/2003 Lawson et al.
2003/0195631 A1 10/2003 Ferree
2003/0199984 A1 10/2003 Trieu
2004/0002762 A1 1/2004 Hawkins
2004/0010316 A1 1/2004 William et al.
2004/0024462 A1 2/2004 Ferree et al.

(Continued)

FOREIGN PATENT DOCUMENTS

EP 0 304 305 2/1989

(Continued)

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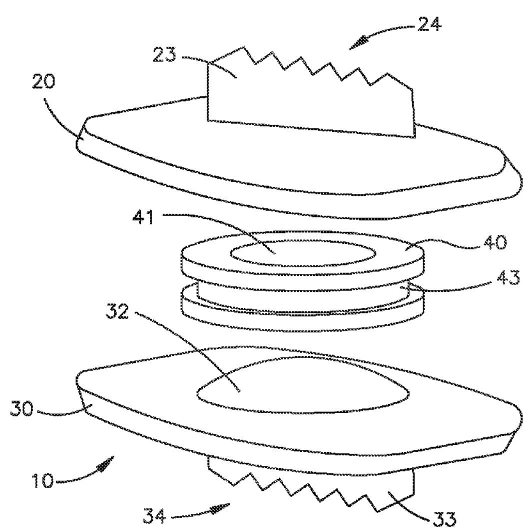
(57) **ABSTRACT**

An intervertebral implant device includes an upper part, a lower part and a core element. The upper part includes an upper surface for engaging a vertebrae and a lower surface which includes a convex portion. The lower part includes a lower surface for engaging a vertebrae and an upper surface having a convex portion. The core element has an upper concave portion to operatively engage with the convex portion on the upper part and a lower concave portion to operatively engage with the convex portion of the lower part. Limited universal movement and translational movement is provided between the upper part and lower part.

32 Claims, 18 Drawing Sheets



U.S. PATENT DOCUMENTS

2004/0093082	A1*	5/2004	Ferree	623/17.11
2004/0127992	A1	7/2004	Serhan et al.	
2004/0133278	A1	7/2004	Marino et al.	
2004/0133281	A1	7/2004	Khandkar et al.	
2004/0138750	A1	7/2004	Mitchell	
2004/0138753	A1	7/2004	Ferree	
2005/0043802	A1	2/2005	Eisermann et al.	

FOREIGN PATENT DOCUMENTS

WO	WO-03/084449	10/2003
WO	WO/2005/053580 A1	6/2005

* cited by examiner

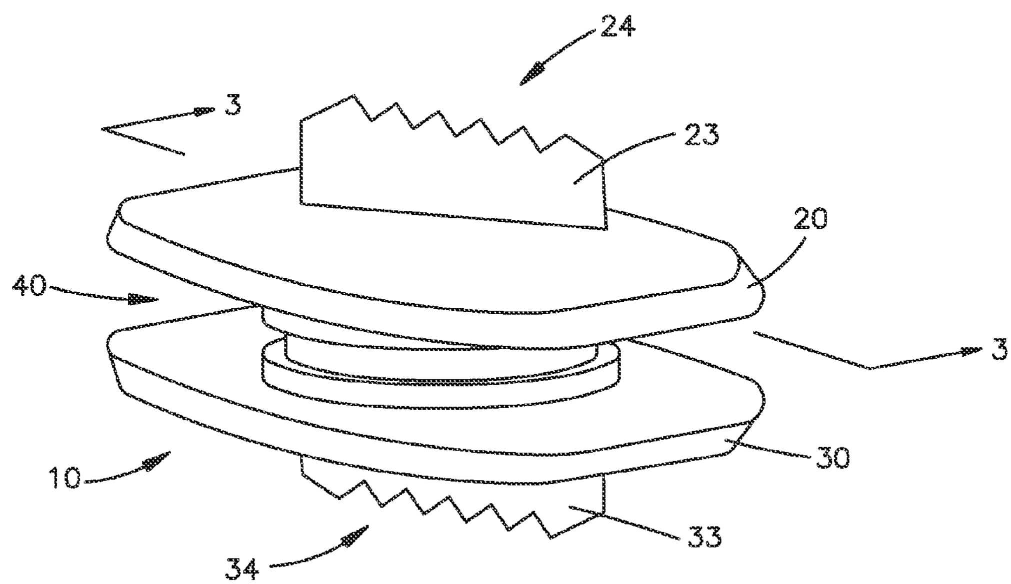
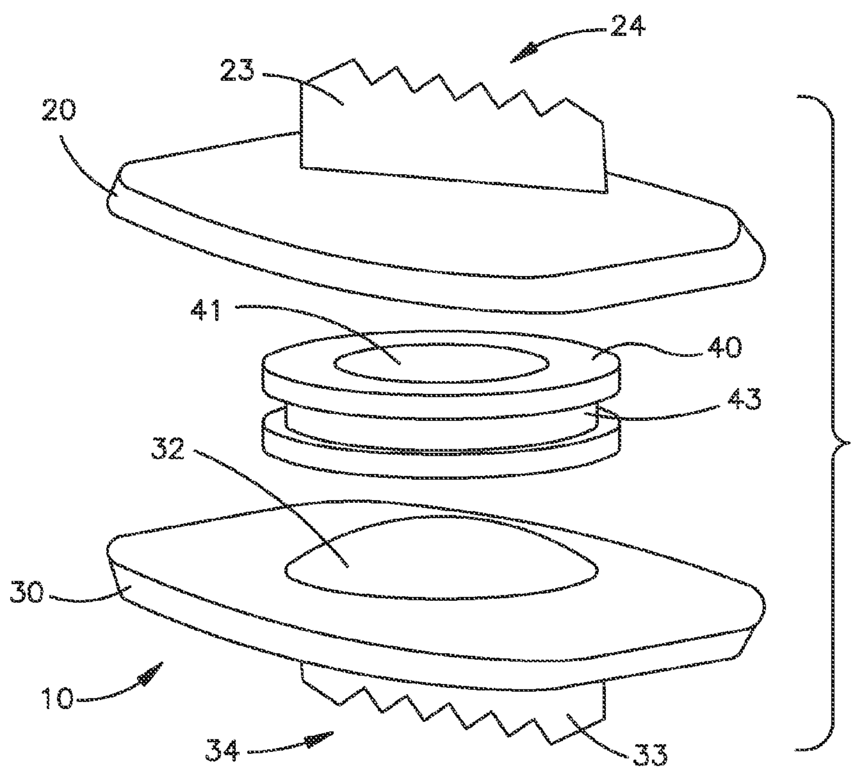


Figure 1



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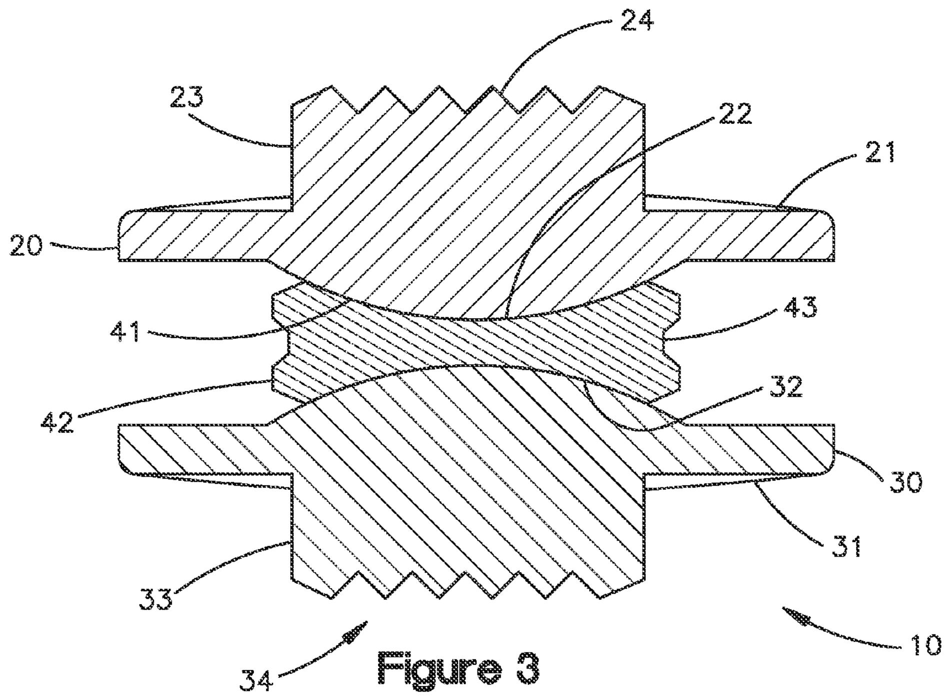

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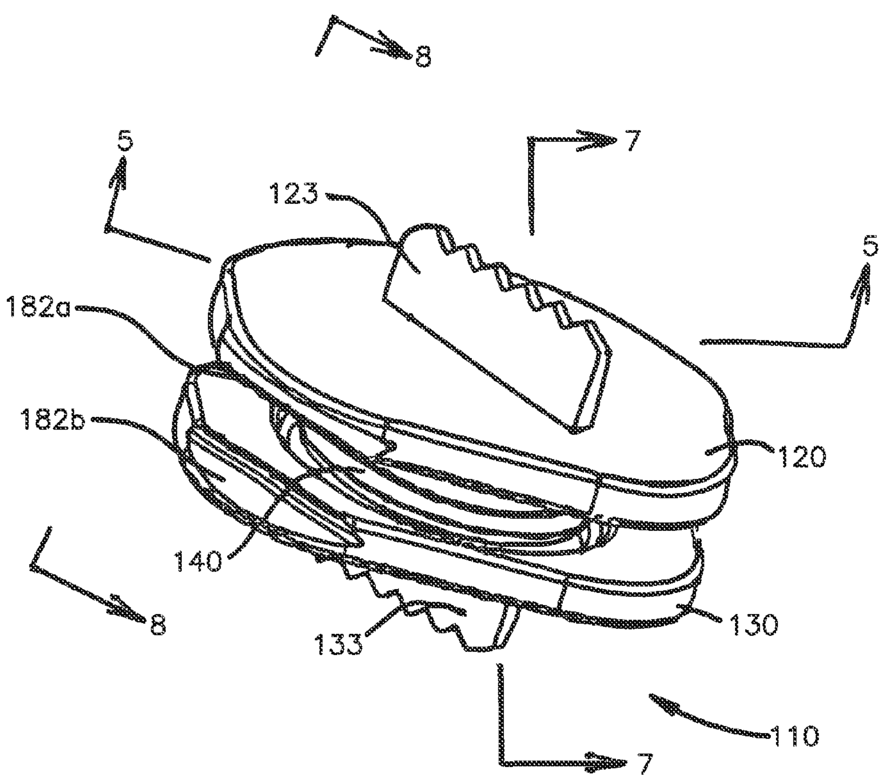

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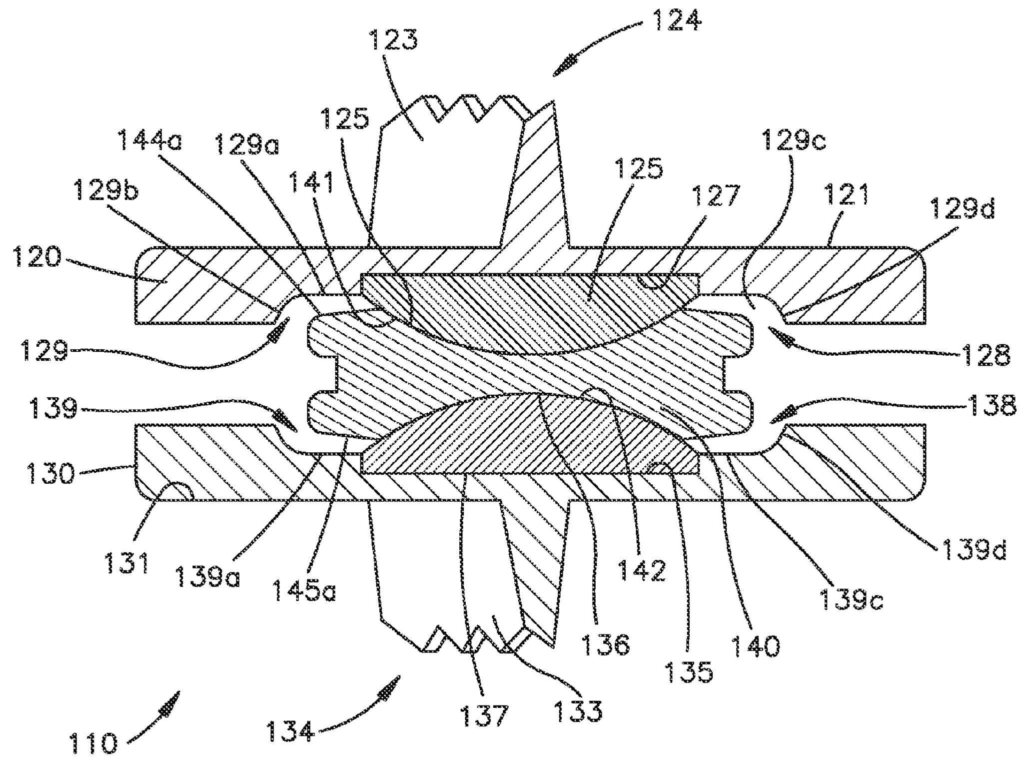

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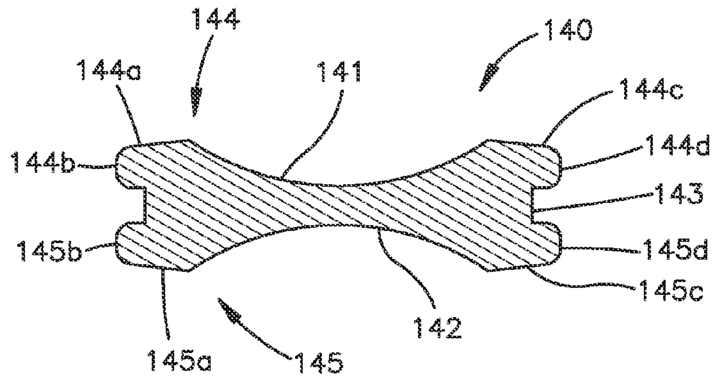

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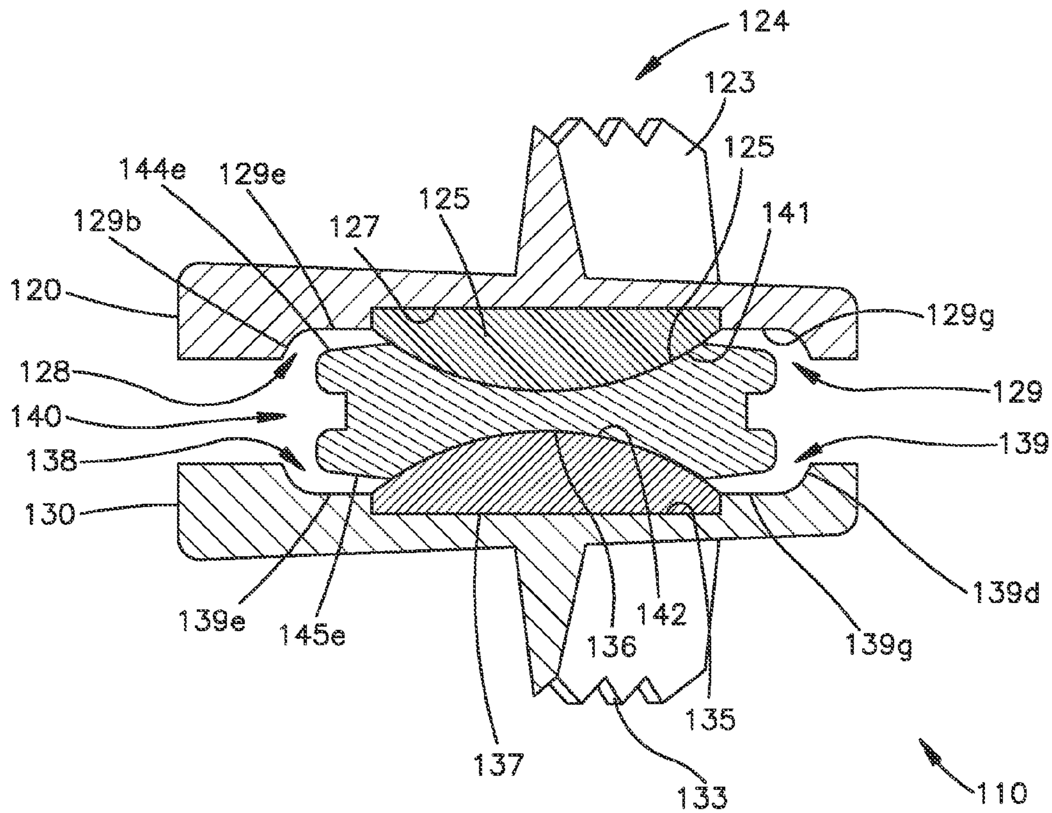

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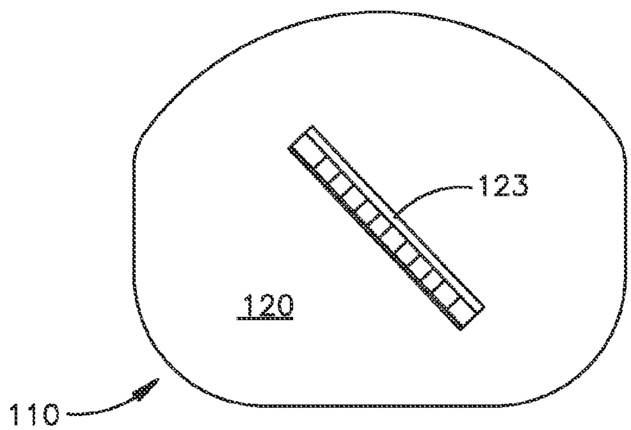

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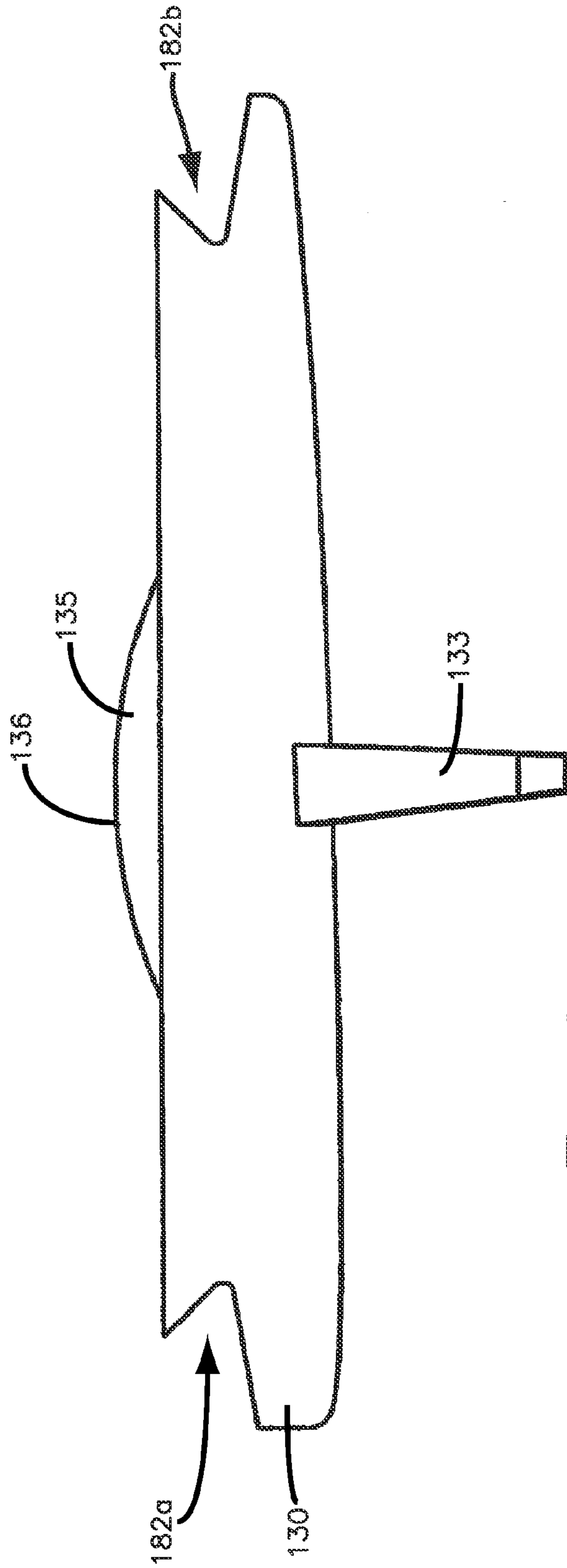
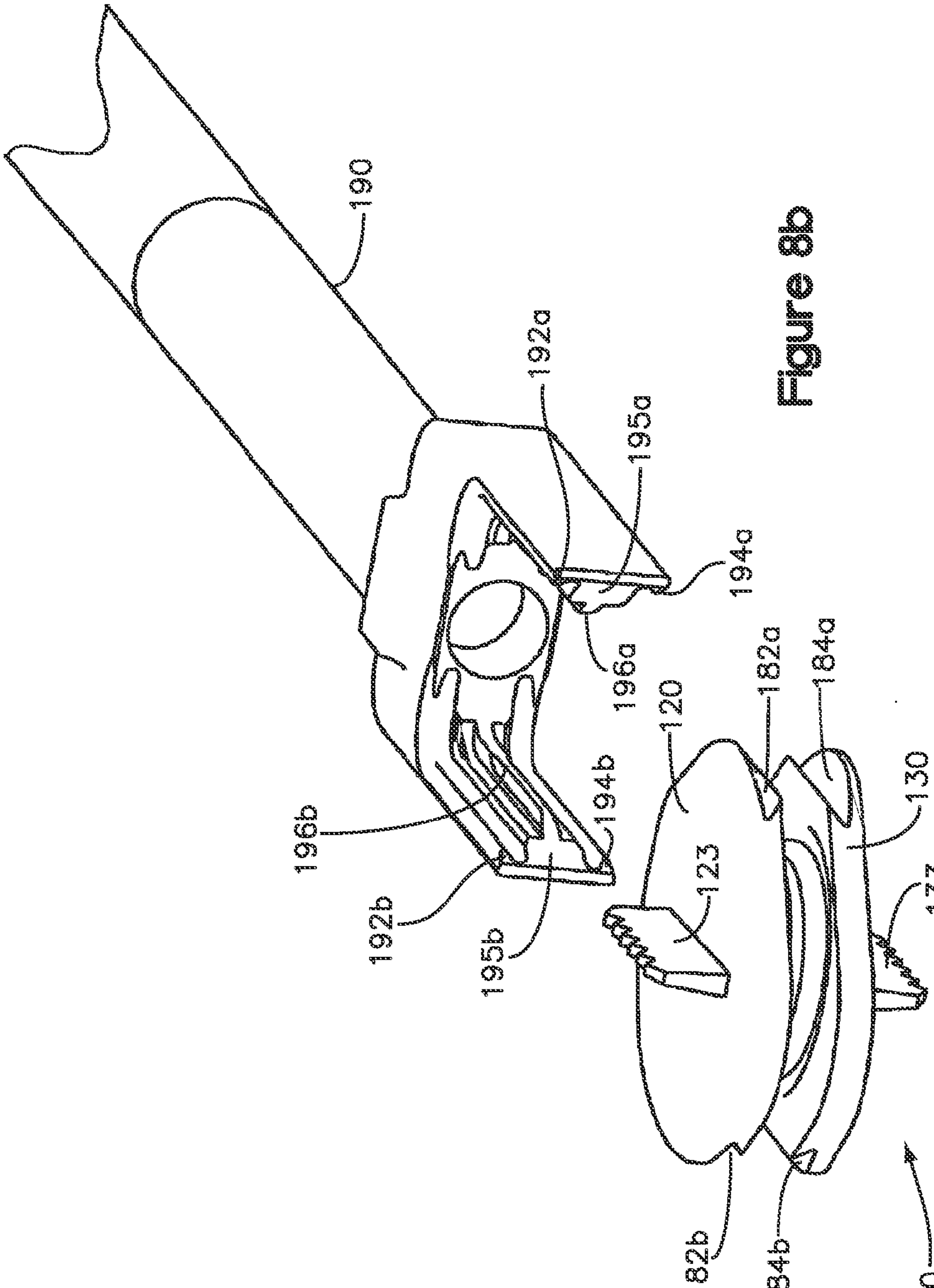


Figure 8a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192a
195a
194a
196a
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182a
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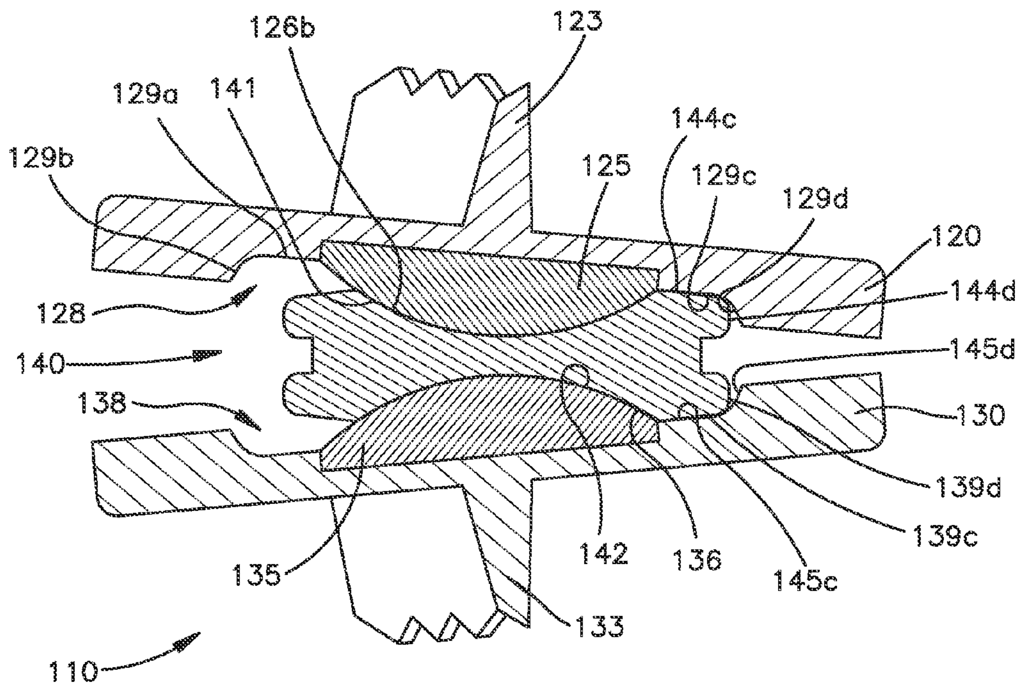
133
123
196b
194b
192b
195b
182b
184b
110

Figure 8b



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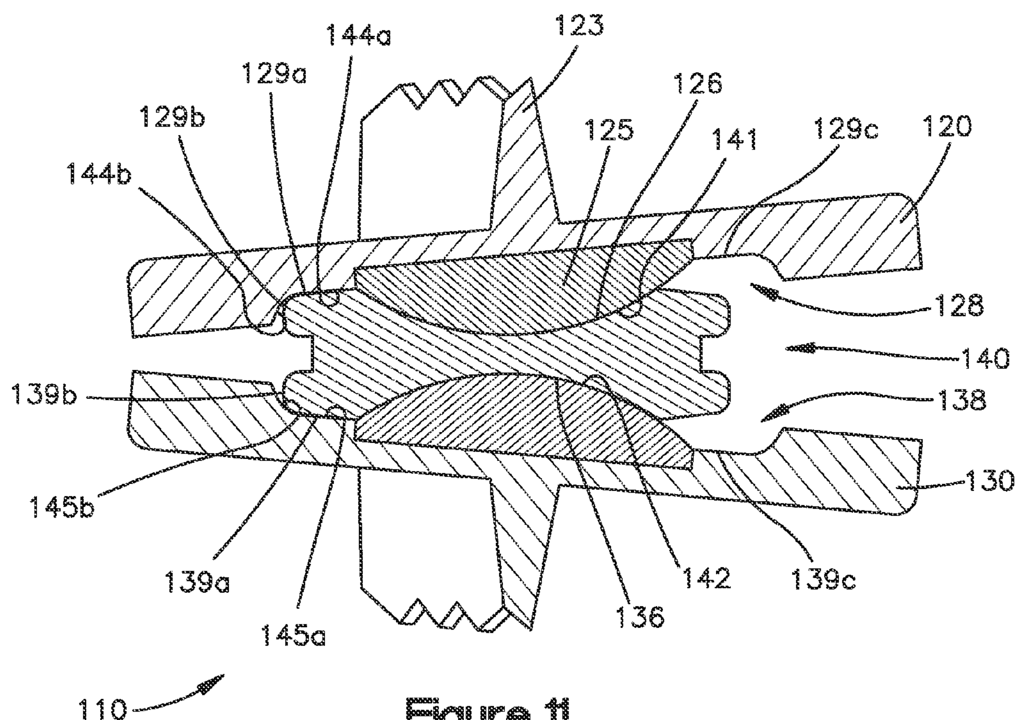

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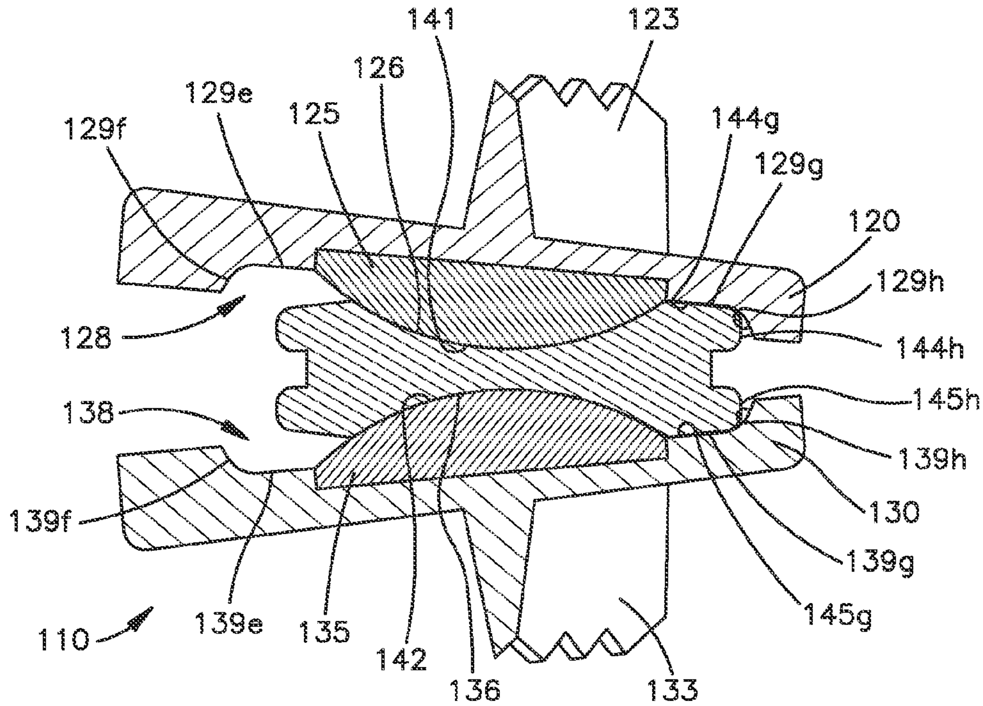

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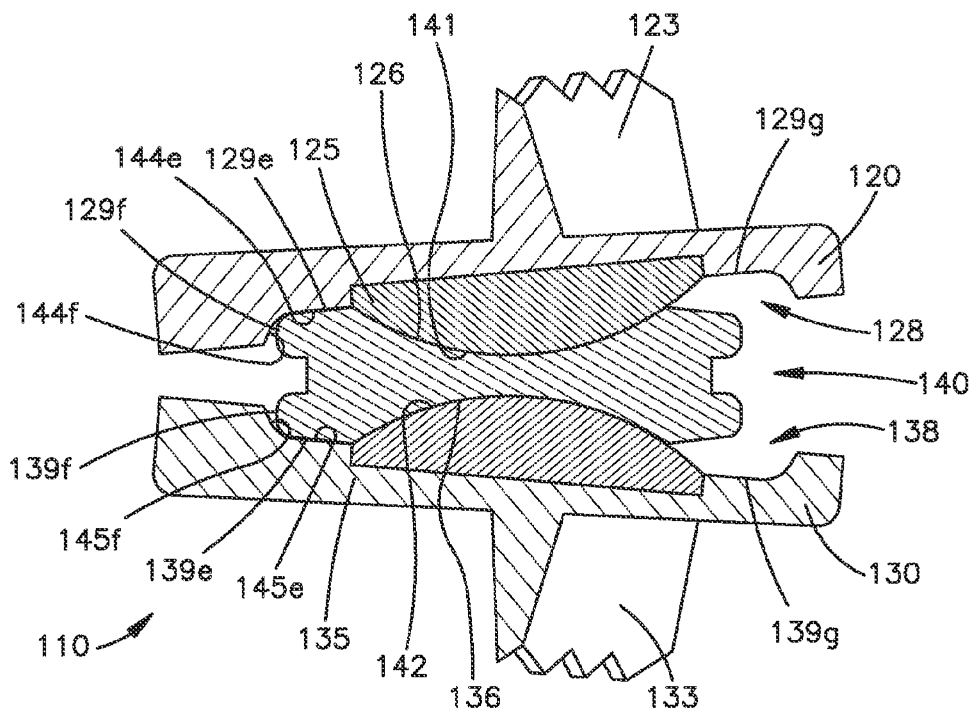

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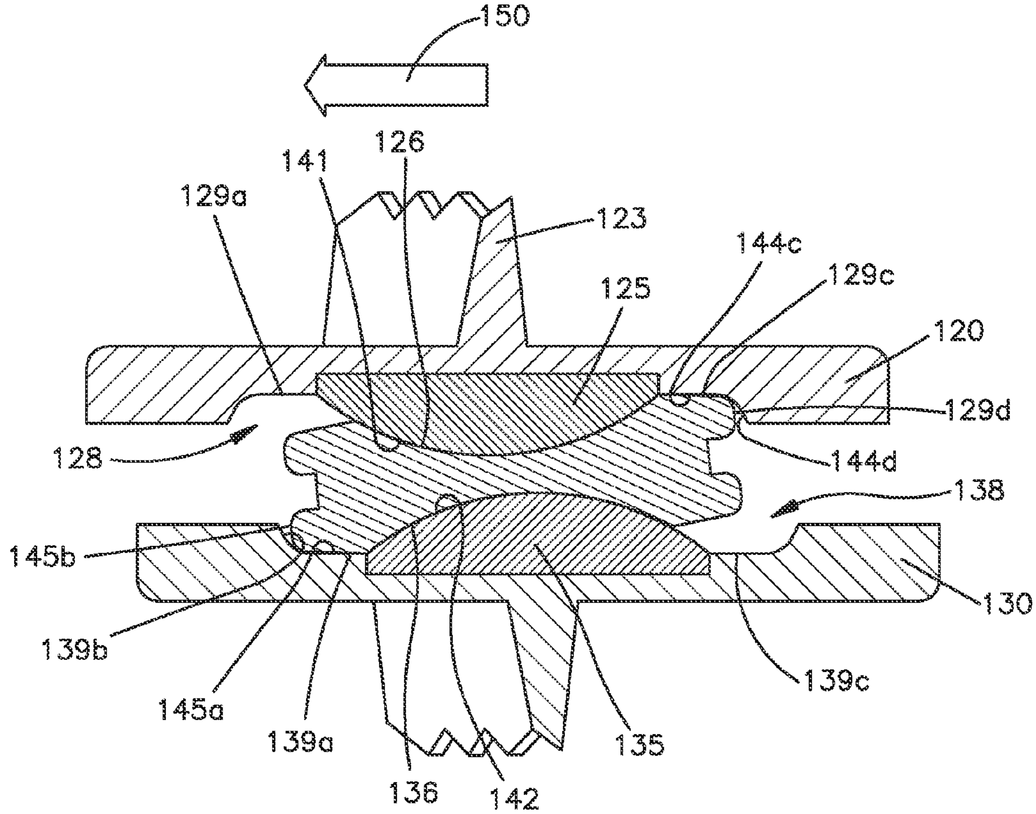

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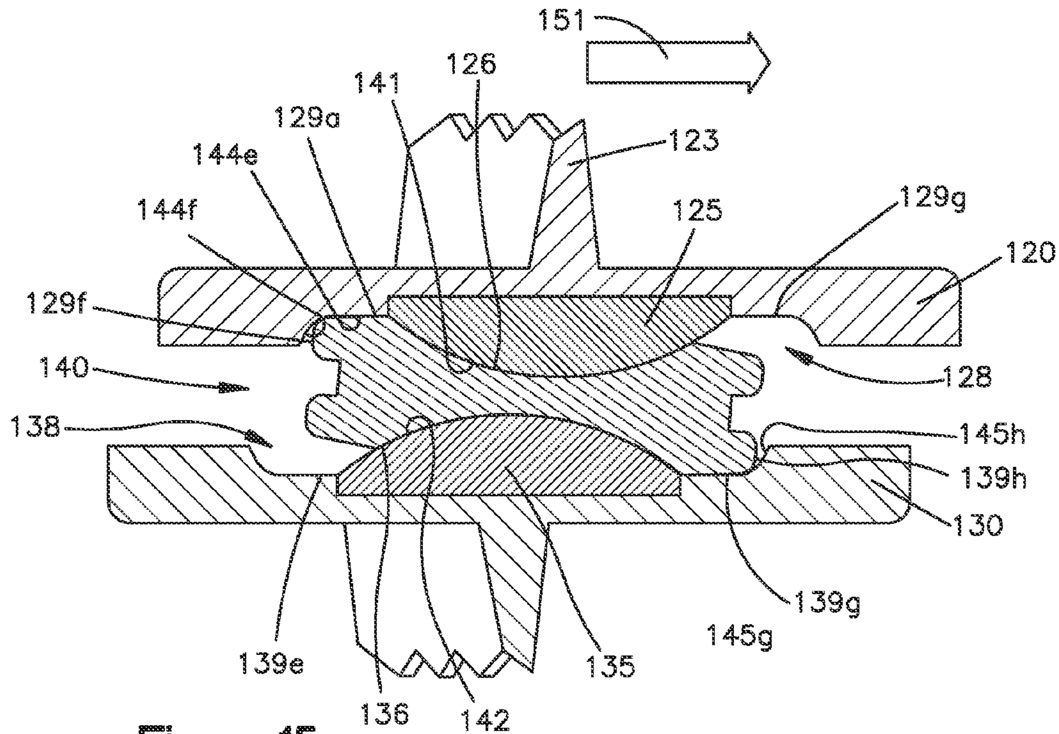

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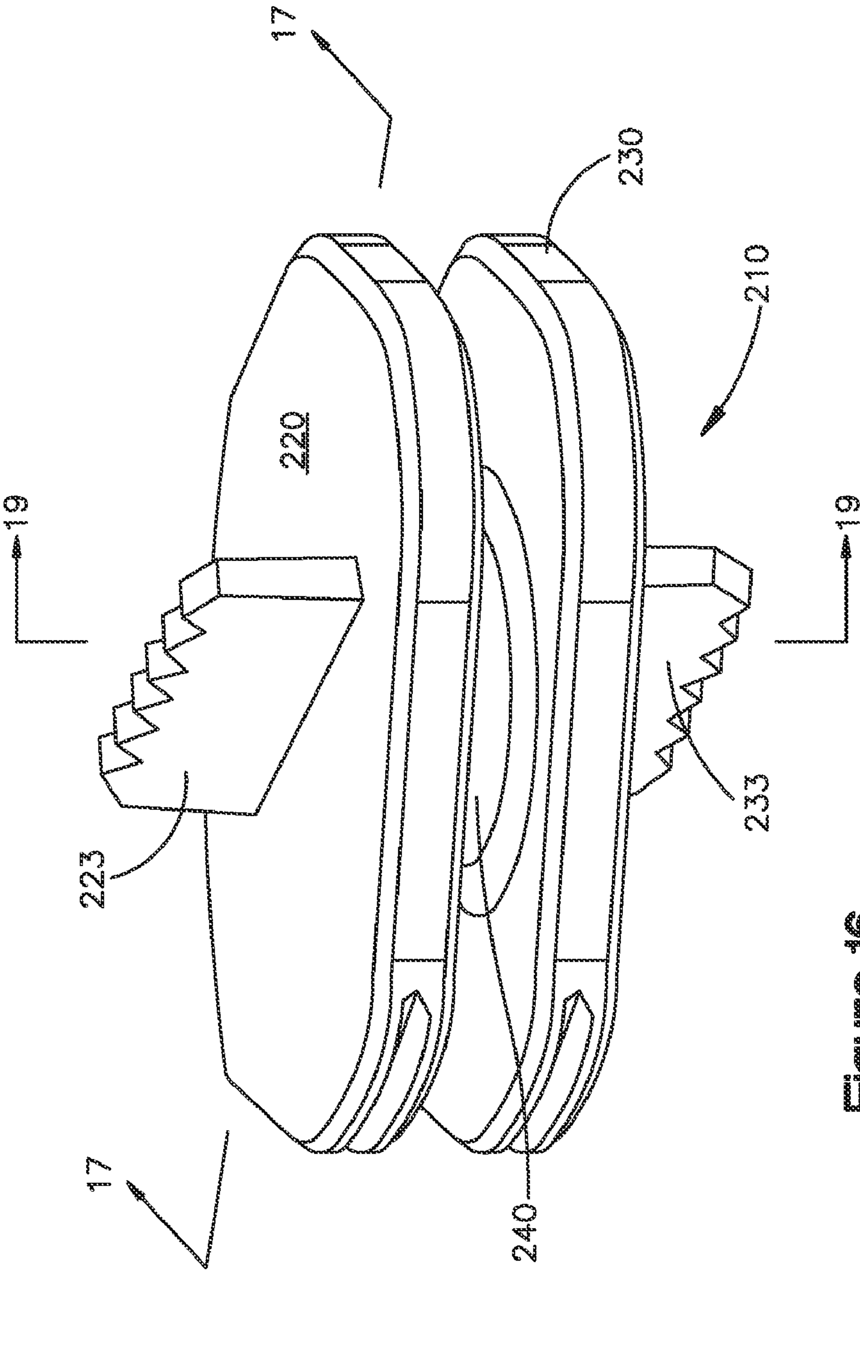

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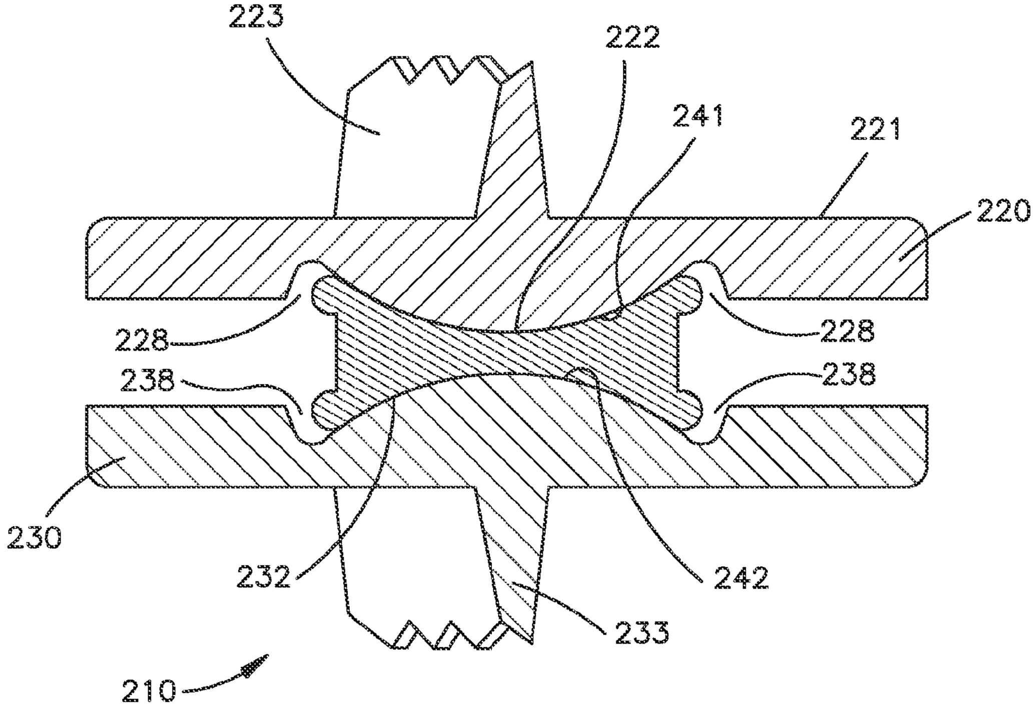

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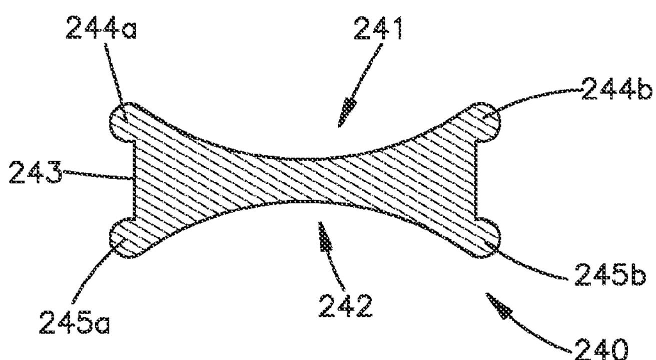

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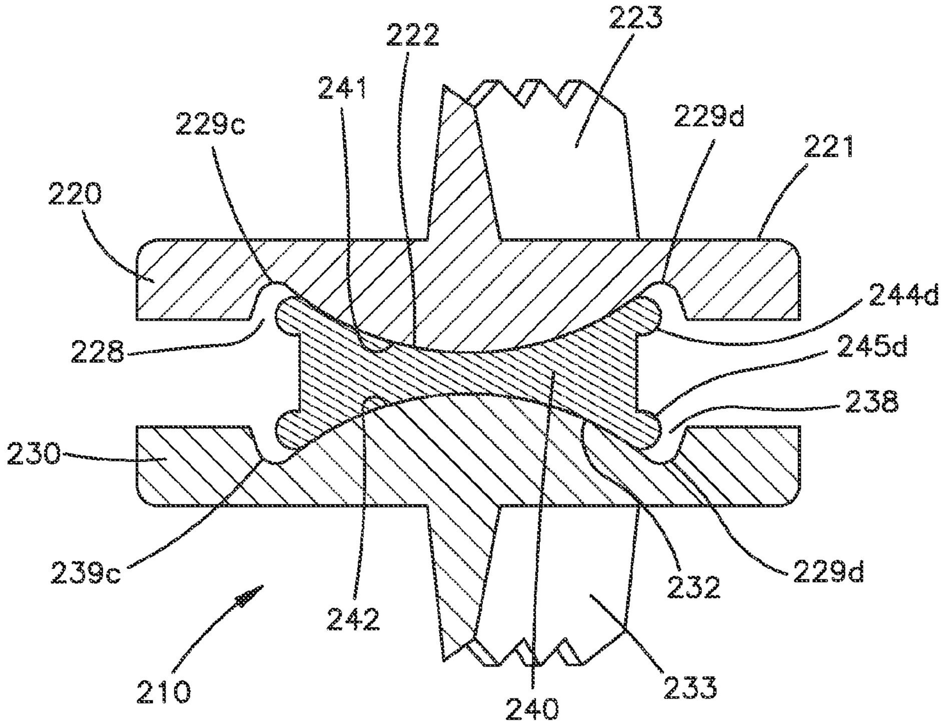

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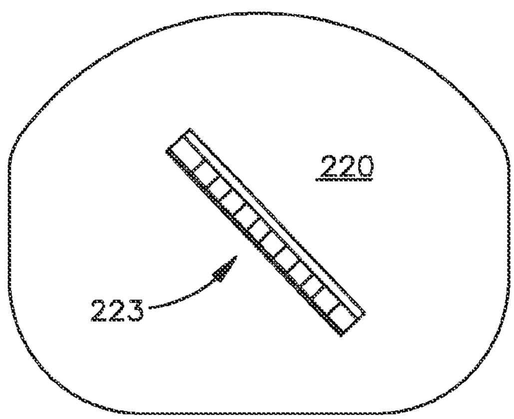

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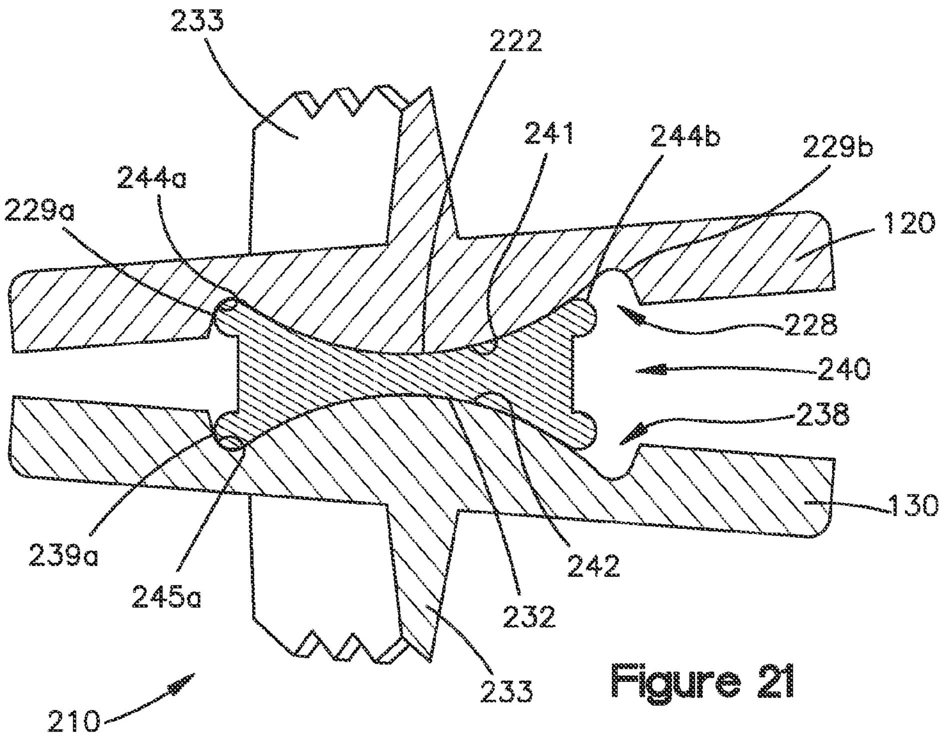
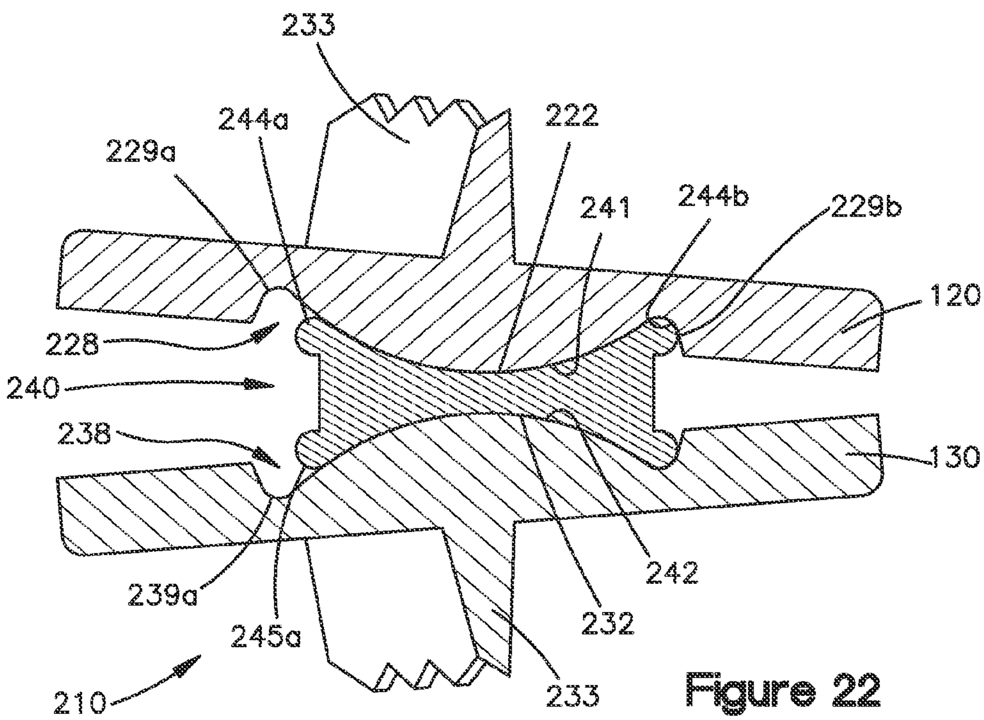


Figure 21



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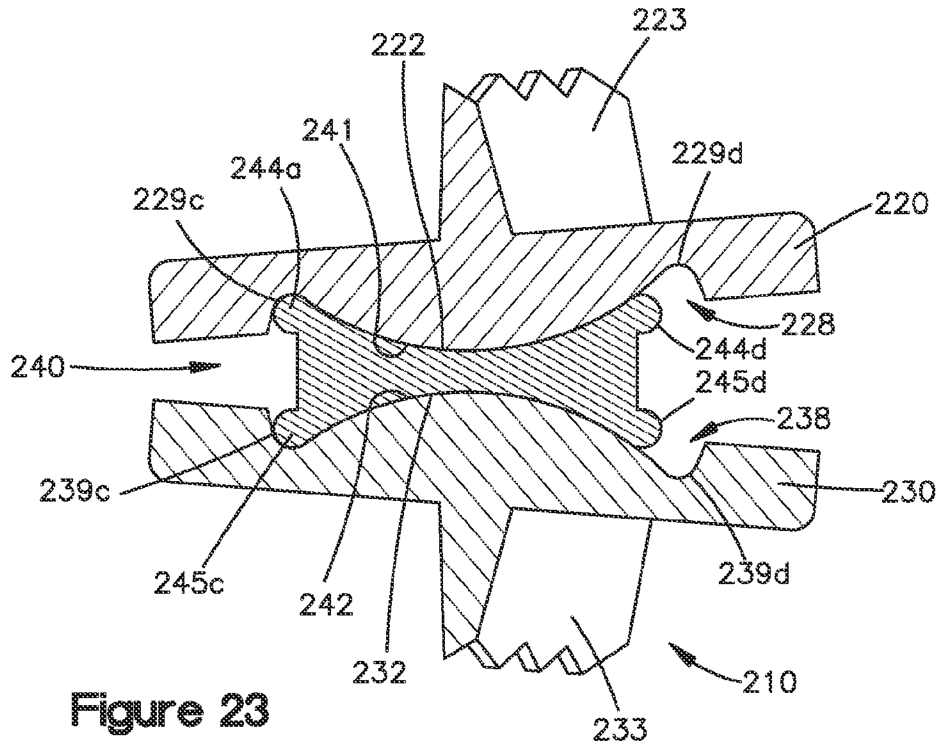

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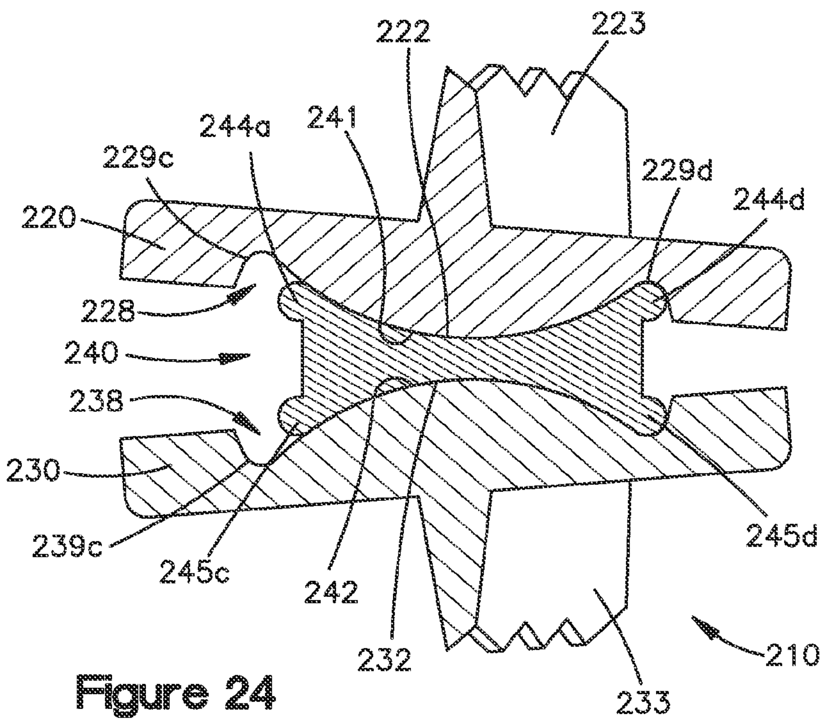

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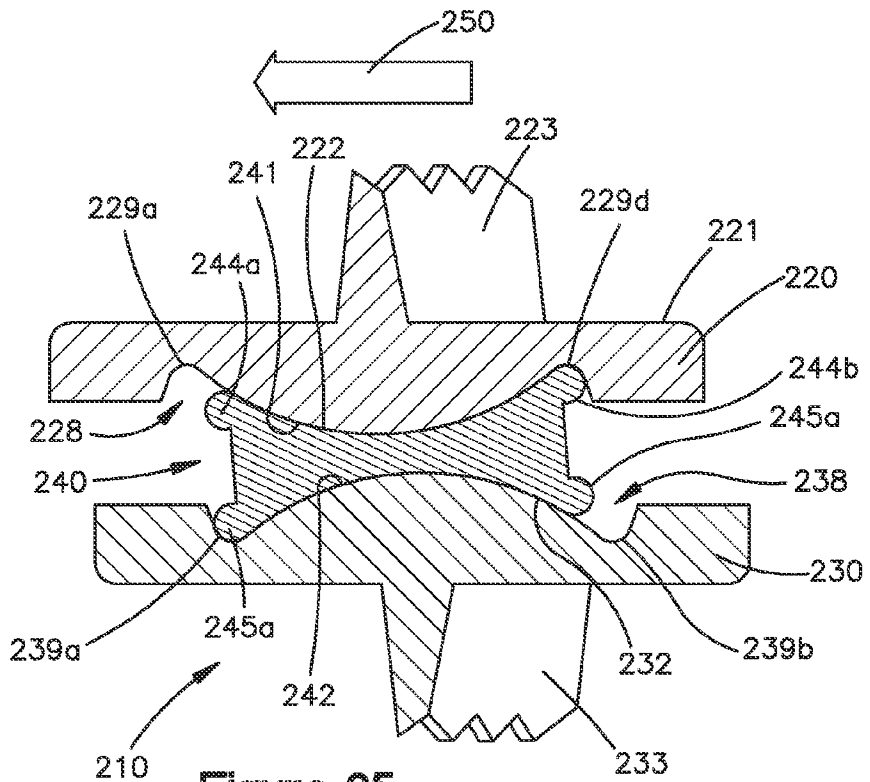

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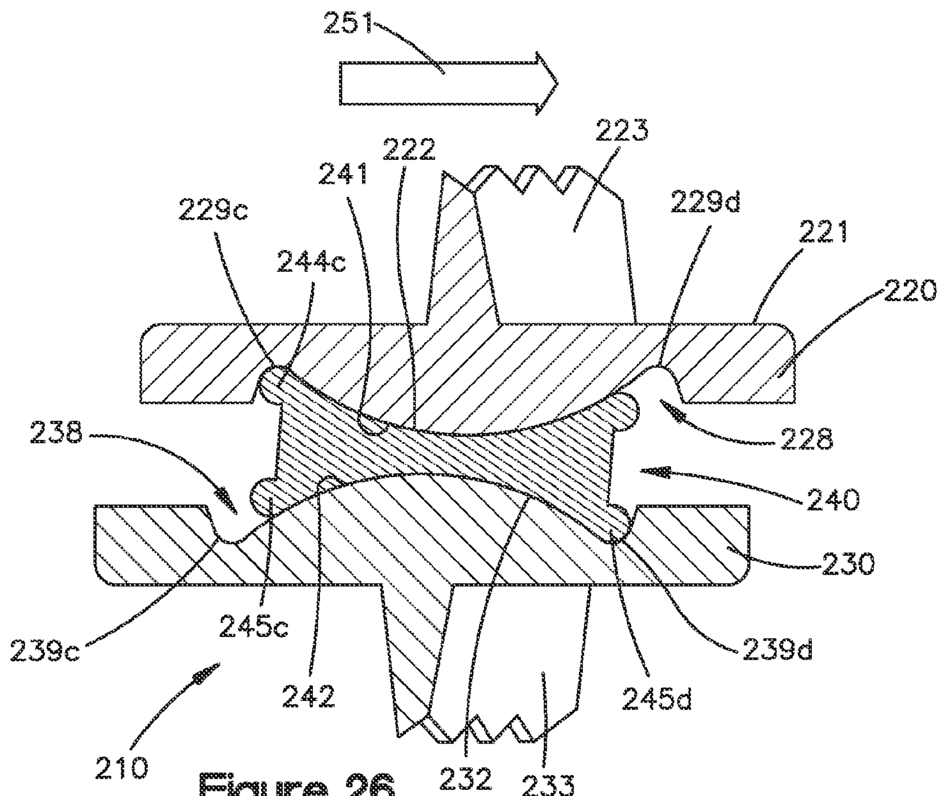

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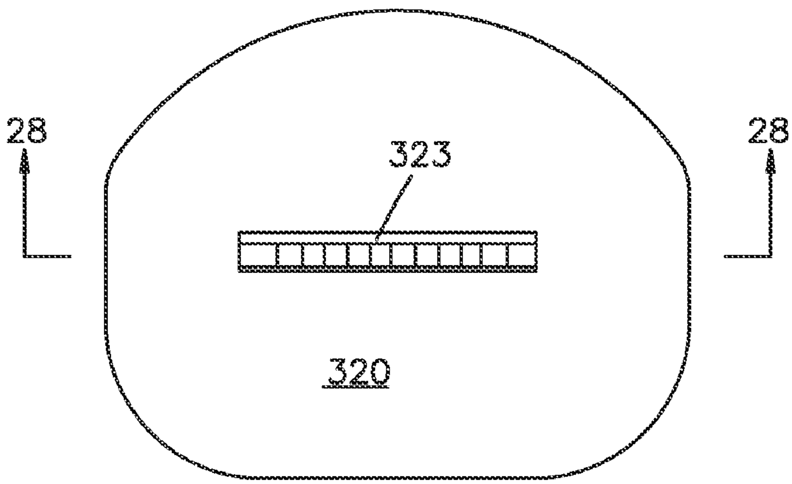

Figure 27

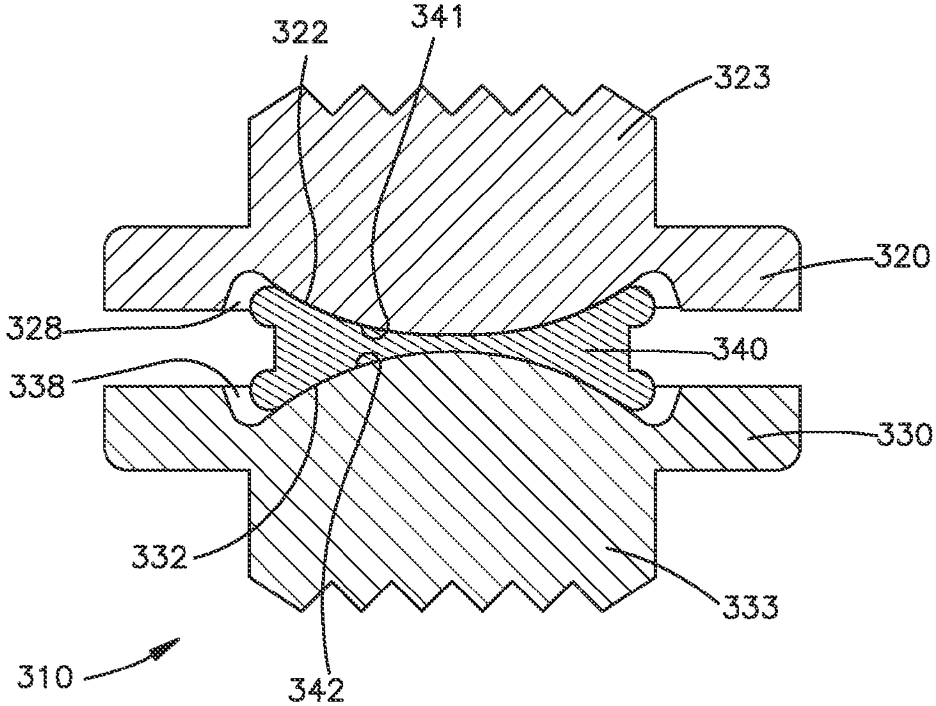

Figure 28

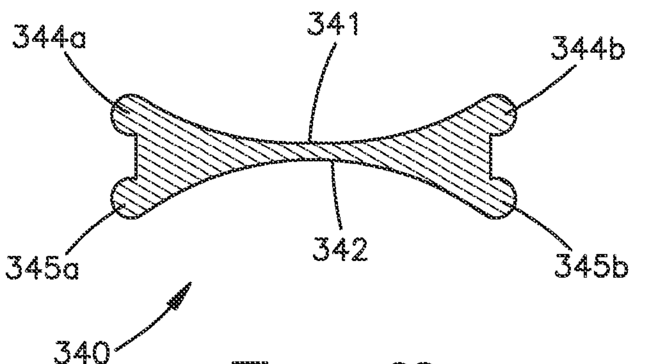

Figure 29

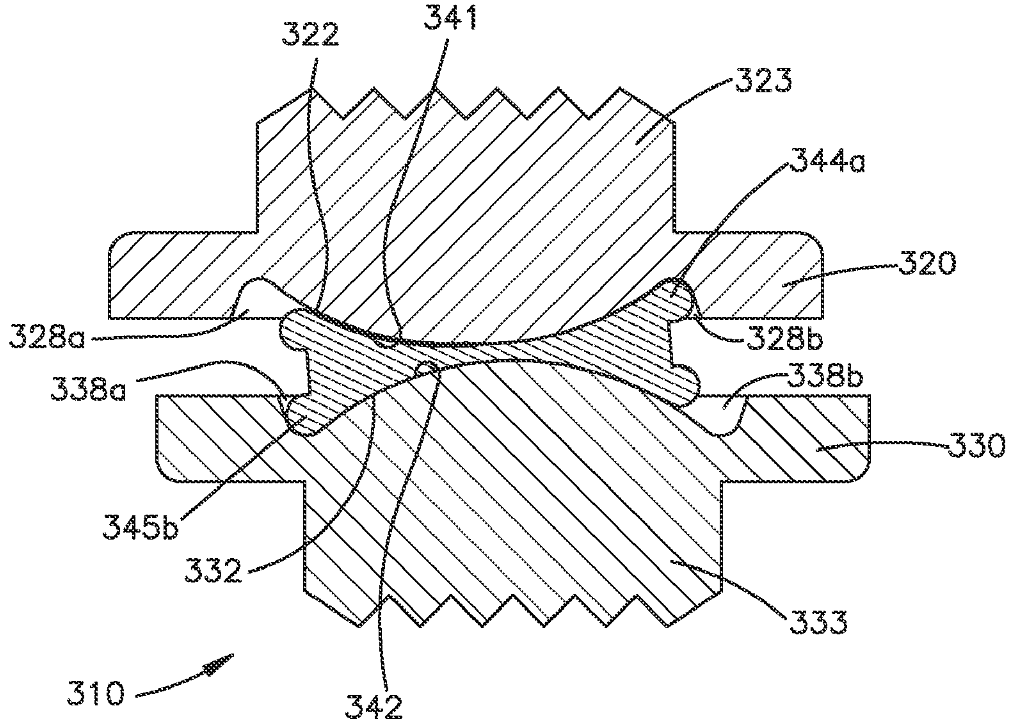

Figure 30

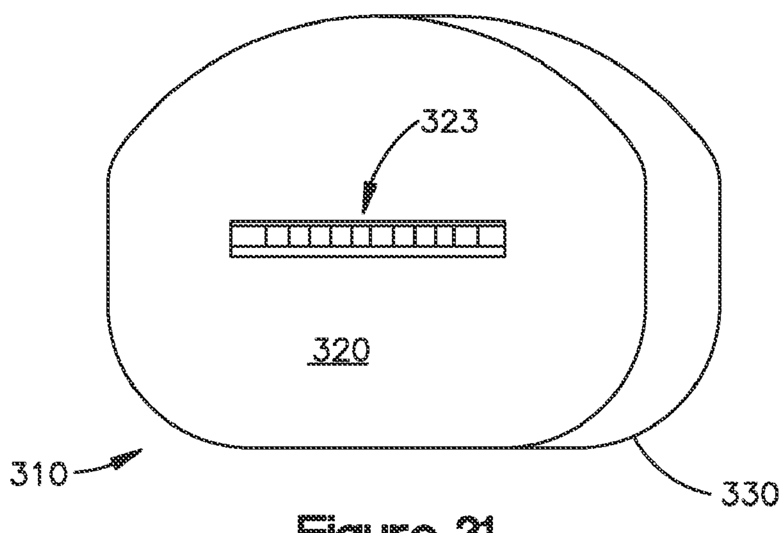

Figure 31

INTERVERTEBRAL IMPLANT

FIELD OF THE INVENTION

The present invention relates to an intervertebral implant, and more specifically, the present invention relates to an intervertebral implant which permits a wider degree of motion of the adjacent vertebrae.

BACKGROUND OF THE INVENTION

Prior intervertebral implants are disclosed by U.S. Pat. No. 5,314,477 and U.S. Patent Publication Application No. 2004/0215198. These references disclose implants which replace a disc removed from the intervertebral space using a total disc replacement procedure. These and other devices have been used in the field of disc replacement which involves the insertion of an artificial intervertebral disc implant into the intervertebral space between adjacent vertebrae, and which allows limited universal movement of the adjacent vertebrae with respect to each other.

Recently, several non-fusion techniques have emerged which treat different stages of degenerative disc disease other than total disc replacement. One of these technologies includes nucleus replacement devices which have been developed to treat early stages of degenerative disc disease. The goal of these technologies is to replace only the nucleus pulposus of the intervertebral disc and to leave the annulus and the ligaments as intact as possible.

Although these prior nucleus replacement intervertebral devices provide limited universal movement, there is a need in the art for new and improved intervertebral devices which provide enhanced universal movement of the adjacent vertebrae with respect to each other.

BRIEF SUMMARY OF THE INVENTION

The present invention relates to a new and improved intervertebral implant device which provides enhanced universal movement of the adjacent vertebrae with respect to each other. In one form, the present implant comprises three components, namely two end plates, i.e., an upper part and a lower part, each having a convex articulating surface, and a biconcave core element disposed between the upper part and the lower part. The device can be inserted into the intervertebral space as a one-piece assembly or as individual components. Insertion is preferably through a lateral or anterolateral approach, while preserving the anterior and posterior longitudinal ligaments. Alternatively, the device can be inserted through an anterior approach. The present implant device replicates the moving nucleus within the intervertebral disc, while also preserving the stability of the segments, i.e., the two end plates and the core element, due to the preservation of anterior and posterior longitudinal ligaments when inserted using a lateral or anterolateral approach.

In one advantageous form, in addition to allowing universal motion in all directions, the present implant provides for horizontal translation of adjacent upper and lower vertebrae.

The present invention, in one form thereof, comprises an intervertebral implant device having an upper part with an upper surface for engaging a vertebrae and a lower surface which includes a convex portion. A lower part includes a lower surface for engaging a vertebrae and an upper surface having a convex portion. A core element has an upper concave portion operatively engaged with the convex portion of the upper part and a lower concave portion operatively engaged

with the convex portion of the lower part. At least one of the upper or lower parts have a groove surrounding its convex portion.

The present invention, in another form thereof, comprises an intervertebral implant device having an upper part and a lower part and a core element therebetween. The upper part has an upper surface for engaging a vertebrae and a lower surface which includes a convex portion. The bottom part has a lower surface for engaging a vertebrae and an upper surface having a convex portion. The core element has an upper concave portion to operatively engage with the convex portion of the upper part and a lower concave portion to operatively engage with the convex portion of the lower part. The upper part and the lower part are laterally translatable relative to each other by surfaces of their respective convex portions sliding along surfaces of the concave portions of the core element.

In one advantageous form, movement of the upper part relative to the lower part is limited by the core element abutting upper part wall surfaces and lower part wall surfaces of grooves formed in the lower surface of the upper part and the upper surface of the lower part, respectively.

The present invention, in another form thereof, comprises an intervertebral implant device having an upper part having an upper surface for engaging a vertebrae and an upper inlay element dimensioned to be disposed in a recess formed therein. The upper inlay element has a lower surface which includes a convex surface facing opposite the upper part recess. The lower part has a lower surface for engaging a vertebrae and a lower inlay element is dimensioned to be disposed in a recess formed therein. The lower inlay element has an upper surface having a convex surface facing opposite the lower part recess. A core element has an upper concave portion which is operatively engaged with the convex surface of the upper part inlay element and a lower concave portion which is operatively engaged with the convex surface of the lower inlay element. The upper part and lower part are translatable relative to each other by surfaces of their respective convex surfaces sliding along surfaces of the concave portions of the core element.

In one advantageous form, movement of the upper part relative to the lower part is limited by the core element abutting upper part wall surfaces and lower part wall surfaces of grooves formed in the lower surface of the upper part and the upper surface of the lower part, respectively.

Objects of the present invention will be apparent from the detailed description to follow, together with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

Preferred embodiments of the invention will now be described by way of example with reference to the accompanying drawings, wherein:

FIG. **1** is a perspective view of an intervertebral implant device in accordance with the present invention.

FIG. **2** is an exploded view of the implant device of FIG. **1**.

FIG. **3** is a cross sectional view of the implant device of FIG. **1** taken in the plane of line **3**-**3** of FIG. **1**.

FIG. **4** is a perspective view of another embodiment of an implant device in accordance with the present invention.

FIG. **5** is a cross sectional view of the implant device of FIG. **4** taken in the plane of line **5**-**5** of FIG. **4**.

FIG. **6** is a core element of the implant device of FIG. **5**.

FIG. **7** is a cross sectional view of the device of FIG. **4** taken in the plane of line **7**-**7** of FIG. **4**.

FIG. **8a** is an elevation view of the lower plate of the device of FIG. **4** taken in the plane of line **8-8**.

FIG. **8b** is a perspective view of the device of FIG. **4** along with an insertion tool in accordance with the present invention.

FIG. **9** is a top plan view of the implant device of FIG. **4**.

FIG. **10** is a cross sectional view of the implant device of FIG. **4** taken in the plane of line **5-5** of FIG. **4** depicting a lateral right bend position.

FIG. **11** is a cross sectional view of the implant device of FIG. **4** taken in the plane of line **5-5** of FIG. **4** depicting a left lateral bend position.

FIG. **12** is a cross sectional view of the implant device of FIG. **4** taken in the plane of line **7-7** of FIG. **4** shown in an extension position.

FIG. **13** is a cross sectional view of the implant device of FIG. **4** taken in the plane of line **7-7** of FIG. **4** depicted in a flexion position.

FIG. **14** is the implant device of FIG. **4** taken in the plane of line **5-5** of FIG. **4** depicted in a lateral translation position.

FIG. **15** is a cross sectional view of the implant device of FIG. **4** taken in the plane of line **7-7** of FIG. **4** shown in a rear translation position.

FIG. **16** is a perspective view of another embodiment of an implant device in accordance with the present invention.

FIG. **17** is a cross sectional view of the implant device of FIG. **16** taken in the plane of line **17-17** of FIG. **16**.

FIG. **18** is a core element of the device of FIG. **17**.

FIG. **19** is a cross sectional view of the implant device of FIG. **16** taken in the plane of line **19-19** of FIG. **16**.

FIG. **20** is a top plan view of the device of FIG. **16**.

FIG. **21** is a cross sectional view of the implant device of FIG. **16** taken in the plane of line **17-17** of FIG. **16**, shown in a left lateral bend position.

FIG. **22** is a cross sectional view of the implant device of FIG. **16** taken in the plane of line **17-17** of FIG. **16**, shown in a right lateral bend position.

FIG. **23** is a cross sectional view of the implant device of FIG. **16** taken in the plane of line **19-19** of FIG. **16**, shown in an flexion position.

FIG. **24** is a cross sectional view of the implant device of FIG. **16** taken in the plane of line **19-19** of FIG. **16**, shown in a extension position.

FIG. **25** is a cross sectional view of the implant device of FIG. **16** taken in the plane of line **17-17** of FIG. **16**, shown in a left lateral translation position.

FIG. **26** is a cross sectional view of the implant device of FIG. **16** taken in the plane of line **19-19** of FIG. **16**, shown in a rear lateral translation position.

FIG. **27** is a top plan view of another embodiment of the implant device in accordance with the present invention.

FIG. **28** is a cross sectional view of the implant device of FIG. **27** taken in the plane of line **28-28** of FIG. **27**.

FIG. **29** is a core element of the implant device of FIG. **28**.

FIG. **30** shows the implant device of FIG. **27** taken in the plane of line **28-28** of FIG. **27**, shown in a lateral translation position.

FIG. **31** is a top plan view of FIG. **30**.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring now to the drawings, like elements are represented by like numerals throughout the several views.

Referring specifically to FIGS. **1-3**, an intervertebral implant device **10** includes an upper part in the form of upper plate **20**, a lower part in the form of lower plate **30** and a core element **40**. The upper plate **20** includes an upper surface **21** and a lower convex surface **22**. An anchor **23** with teeth **24** is designed to fit tightly and securely into a slot formed in an upper vertebrae with the upper surface **21** adjacent the lower surface of the upper vertebrae. Similarly, the lower plate **30** includes a lower surface **31**, an upper convex surface **32** and an anchor **33** with anchor teeth **34**. When the device **10** is implanted, the anchor **33** fits tightly in a slot formed in a lower vertebrae with the lower surface **31** adjacent the upper surface of the lower vertebrae.

The anchors **23**, **33** are parallel to a major longitudinal plane through the implant device **10**. The parallel orientation of the anchors **23**, **33** relative to the major longitudinal plane of the implant device is advantageous for insertion of the device into the intervertebral space.

The core **40** includes an upper concave portion **41**, a lower concave portion **42** and a circumferential groove **43**. The upper concave portion **41** and lower concave portion **42** abut lower convex surface **22** of upper plate **20** and upper convex surface **32** of lower plate **30**, respectively. As a result, the convex surfaces **22**, **32** each provide an articulating surface with the upper concave portion **41** and lower concave portion **42** of the core **40**, respectively. Circumferential groove **43** is designed to engage with an insertion tool for use during insertion of the implant device **10** in order to properly manipulate the core **40** between upper plate **20** and lower plate **30**.

The upper plate **20** and lower plate **30** may be formed of an appropriate metallic material such as CoCr or titanium. Similarly, the core element **40** may be composed of the same or different appropriate metallic material as the upper plate **20** and lower plate **30**.

The implant device **10** can be inserted as a single piece assembly or as individual components, namely upper plate **20**, lower plate **30** and core element **40**. Advantageously, implant device **10** can be inserted through either a lateral or anterolateral approach, thus preserving the anterior and posterior longitudinal ligaments. Alternatively, implant device **10** can be inserted through an anterior approach. The implant device **10** replicates the moving nucleus within an intervertebral disc. The stability of the upper plate, lower plate and core element is provided in part due to the preservation of all of the anterior and posterior longitudinal ligaments resulting from a lateral or anterolateral approach.

Insertion of the implant device **10** may be provided by a suitable surgical technique. For example, in a lumbar spine surgical technique of one advantageous method, one can generally use either a lateral or anterolateral approach to gain access to the pathologic level of the lumbar spine. However other techniques including an anterior approach can be used. Of course in the embodiment of FIGS. **1-3**, since the anchors **23**, **33** are in transverse planes, this embodiment, as shown, would more preferably be inserted only laterally.

During lateral or anterolateral insertion, upper and lower slots are formed in respective upper and lower vertebrae for accommodating anchors **23**, **33**. Lateral discectomy preserves all anterior and posterior longitudinal ligaments and some of the original disc annulus in order to allow for adequate upper plate and lower plate coverage to prevent subsidence, i.e., the unintentional movement of the upper plate relative to the lower plate. The implant device **10** is pre-assembled by inserting core **40** between upper plate **20** and lower plate **30** and the entire implant device **10** is inserted into the intervertebral space for attachment to the upper and lower vertebrae.

Referring generally to FIGS. **4-15**, implant device **110** is another embodiment of the present invention. Similar elements to those of device **10** are similarly numbered but increased by 100 in FIGS. **4-15**. FIGS. **4-7** and **9** depict the implant device in a neutral position and FIGS. **10-15** depict the implant device **10** in various different operative orientation positions.

Referring now specifically to FIGS. **4-15**, implant device **110** comprises upper plate **120**, lower plate **130** and core **140**. Upper plate **120** includes an upper surface **121** and an anchor **123** with teeth **124**. Lower plate **130** includes lower surface **131** and anchor **133** with teeth **134**. When implanted, anchors **123**, **133** fit tightly into slots formed in upper and lower vertebrae, respectively, with upper surface **121** and lower surface **131** being adjacent upper and lower vertebrae surfaces, respectively.

The anchors **123**, **133** are shown at a 45 degree angle relate to the major longitudinal plane through the implant device **110**. The 45 degree angle orientation of the anchors **123**, **133** is advantageous for an anterolateral approach insertion. However, the anchors **123**, **133** can be at any angle between 0 and 90 degrees relative to the major longitudinal plane.

Upper plate **120** and lower plate **130** are composed of a suitable metallic material which includes, but is not limited to, CoCr and titanium or a suitable ceramic material. Advantageously, upper plate **120** and lower plate **130** are composed of the same material although the plates may be composed of different materials.

Upper convex inlay **125** is disposed in recess **127** formed in a bottom surface of upper plate **120**, and has a lower convex surface **126** opposite the recess **127**. Similarly, lower convex inlay **135** is disposed in recess **137** of lower plate **130** with an upper convex surface **136** opposite the recess **137**. Upper convex inlay **125** and lower convex inlay **135** may be composed of an appropriate material including various plastics and polymers such as polyethylene, as well as a ceramic material.

Formed in the bottom surface of the upper plate **120**, surrounding recess **127**, is an upper groove **128**. Upper groove **128** extends 360 degrees around the lower convex surface **126**. A lower groove **138** is similarly formed in an upper surface of lower plate **130** surrounding recess **137**, and extending 360 degrees around the upper convex surface **136**.

Within the upper groove **128** are groove wall surfaces **129** including groove floor surfaces **129***a*, **129***c*, **129***e*, **129***g* and groove side wall surfaces **129***b*, **129***d*, **129***f*, **129***h*. Depicted in FIGS. **4-15**, groove floor surfaces **129***a*, **129***c*, **129***e*, **129***g* are parallel to a horizontal plane. Alternatively, groove floor surfaces **129***a*, **129***c*, **129***e*, **129***g* can be at an angle relative to a horizontal plane. For example, in one alternative embodiment, the groove floor surfaces **129***a*, **129***c*, **129***e*, **129***g* can slope upward as they extend radially.

Within lower groove **138** are groove wall surfaces **139** including groove floor surfaces **139***a*, **139***c*, **139***e*, **139***g* and groove side wall surfaces **139***b*, **139***d*, **139***f*, **139***h*. Like groove floor surfaces **129***a*, **129***c*, **129***e*, **129***g*, groove floor surfaces **139***a*, **139***c*, **139***e*, **139***g* are parallel to a horizontal plane. Alternatively, groove floor surfaces **139***a*, **1139***c*, **139***e*, **139***g* can slope downwardly, as they extend radially. For example, in one alternative embodiment, groove surfaces **139***a*, **139***c*, **139***e*, **139***g* can slope downwardly at a 5 degree angle.

Core **140** has upper concave portion, i.e., concave surface **141**, and lower concave portion, i.e., concave surface **142**, and circumferential external groove **143**. Upper concave surface **141** provides an articulating surface with lower convex surface **126** and lower concave surface **142** provides an articulating surface with upper convex surface **136**.

Referring now specifically to FIG. **6** along with FIGS. **5** and **7**, core element **140** includes upper surfaces **144** and lower surfaces **145**. The upper surfaces **144** include upper angled surfaces **144***a*, **144***c*, **144***e*, **144***g* and upper circumferential surfaces **144***b*, **144***d*, **144***f*, **144***h*. The lower surfaces **145** include angled surfaces **145***a*, **145***c*, **145***e*, **145***g* and lower circumferential surfaces **145***b*, **145***d*, **145***f*, **145***h*.

In the alternative embodiment in which the upper groove floor surfaces **129***a*, **129***c*, **129***e*, **129***g* and lower groove floor surfaces **139***a*, **139***c*, **139***e*, **139***g* are sloped, upper angled surfaces **144***a*, **144***c*, **144***e*, **144***g* would be sloped at an angle in an opposite direction to that of upper groove floor surfaces **129***a*, **129***c*, **129***e*, **129***g* and lower angled surfaces **145***a*, **145***c*, **145***e*, **145***g* would be sloped at an angle in the opposite direction to that of lower groove floor surfaces **139***a*, **139***c*, **139***e*, **139***g*.

The upper and lower core angled surfaces **144***a*, **144***c*, **144***e*, **144***g* and **145***a*, **145***c*, **145***e*, **145***g*, sloping away from the upper and lower groove floor surfaces **129***a*, **129***c*, **129***e*, **129***g* and **139***a*, **139***c*, **139***e*, **139***g*, results in a larger gap being formed between upper angled surfaces **144***a*, **144***c*, **144***e*, **144***g* and upper groove floor surfaces **129***a*, **129***c*, **129***e*, **129***g*, and between lower angled surfaces **145***a*, **145***c*, **145***e*, **145***g* and lower groove floor surfaces **139***a*, **139***c*, **139***e*, **139***g* when implant device **110** is in its neutral position, as compared with a gap that would be formed were the respective core surfaces not angled. The comparatively larger gap provides enhanced relative movement of the upper part **120** relative to the lower part **130**. In the alternative embodiment where the groove floor surfaces **129**, **139** are sloped in a direction opposite to that of the respective core angled surfaces, an even larger gap would be formed, thus providing additional relative movement between the upper plate **120** and lower plate **130**.

Device **110** is inserted between adjacent vertebrae in a manner similar to that described above with regard to implant **10** except that with the anchors oriented at 45 degrees this implant would be inserted anterolaterally in one advantageous method. Accordingly, implant **110** is inserted into the intervertebral space as a single unified device with core **140** disposed between upper plate **120** and lower plate **130** or as individual components. Device **110** provides limited universal movement of the upper plate **120** with respect to the lower plate **130** as well as lateral translational movement of the upper plate **120** relative to the lower plate **130**. Limitation of the universal movement and horizontal translation is provided by the interaction of the core **140** with the upper groove **128** and lower groove **138** as described in detail with regard to FIGS. **10-15**.

Referring now specifically to FIGS. **10** and **11**, implant device **110** provides for right lateral bending (FIG. **10**) and left lateral bending (FIG. **11**). During a right lateral bend, convex surface **126** of the upper part and upper convex surface **136** of the lower part articulate along respective upper concave surface **141** and lower concave surface **142**, respectively, of core **140**. As a result, during a right lateral bend, core **140** slides into grooves **128**, **138**, with upper angled surface **144***c* abutting upper groove floor surface **129***c*, upper circumferential surface **144***d* abutting upper groove side wall surface **129***d*, lower angled surface **145***c* abutting lower groove floor surface **139***c*, and lower circumferential surface **145***d* abutting lower groove side wall surface **139***d*, in a maximum right lateral bend as depicted in FIG. **10**. Similarly, during a left lateral bend, the upper plate **120** and lower plate **130** pivot towards one another along the convex surfaces **126**, **136** which articulate with concave surfaces **141**, **142**, respectively, of core **140** so that upon a maximum left lateral bend, upper core surfaces **144***a*, **144***b* and lower core surface **145***a*, **145***b* will be disposed in grooves **128**, **138** of upper plate **120**, lower plate **130**, respectively, and abut corresponding wall surfaces of the respective groove **128**, **138**

Limitation on the mobility of the upper plate **120** relative to the lower plate **130** is provided by upper core surfaces **144** and lower core surfaces **145** abutting corresponding groove surfaces **129**, **139**. For example, during a right lateral bend, at its maximum point, upper core surface **144***c* abuts upper groove floor surface **129***c*, upper circumferential surface **144***d* abuts upper groove side wall surface **129***d*, lower core surface **145***c* abuts lower groove floor surface **139***c* and lower circumferential surface **145***d* abuts lower groove side wall surface **139***d*. Similarly, during a left lateral bend, at its maximum point, upper core surfaces **144***a*, **144***b* abut upper groove surfaces **129***a*, **129***b*, respectively, and lower core surfaces **145***a*, **145***b* abut lower groove surfaces **139***a*, **139***b*, respectively.

Referring now to FIG. **12**, in an extension position, lower convex surface **126** and upper convex surface **136** will articulate along upper concave surface **141** and lower concave surface **142** of core **140**, respectively. In a maximum extension position depicted in FIG. **12**, upper core surfaces **144***g*, **144***h* and lower core surfaces **145***g*, **145***h* are disposed in grooves **128**, **138** and abut corresponding groove surfaces, namely upper core surfaces **144***g*, **144***h* abut groove surfaces **129***g*, **129***h*, respectively, and lower core surfaces **145***g*, **145***h* abut groove surfaces **139***g*, **139***h*, respectively.

Referring now to FIG. **13**, in a flexion position of device **110**, at its maximum flexion position, upper core surfaces **144***e*, **144***f* and lower core surface **145***e*, **145***f* will be disposed in upper groove **128** and lower groove **138**, respectively, and abut corresponding groove wall surfaces.

As with the limitation of right and left lateral bending, maximum flexion and extension is provided by upper core surfaces **144** and lower core surfaces **145** interacting and abutting upper and lower groove wall surfaces **129**, **139**, respectively.

Implant device **110** also provides lateral translation in all 360 degrees. FIG. **14** depicts a lateral translation of the implant device **110** wherein the upper part moves in the direction of arrow **150** relative to the lower part and FIG. **15** depicts a rear translation of implant device **110** wherein the upper part moves in a rear direction relative to the lower part as indicated by arrow **151**. Translation of upper plate **120** relative to lower plate **130** in a translational direction, e.g., direction **150** or **151**, is provided by the sliding articulation of the lower convex surface **126** of upper plate **120** with the upper concave surface **141** of core **140** in an opposite direction relative to the articulation of the upper convex surface **136** of lower plate **130** along lower concave surface **142** of core **140**.

Referring specifically to the lateral translation in FIG. **14**, a translation of upper plate **120** in the direction of arrow **150**, relative to lower plate **130**, results in lower core surfaces **145***a*, **145***b* being slid into groove **138** and upper core surfaces **144***c*, **144***d* sliding into upper groove **128**, with lower core surface **145***a* abutting lower groove floor surface **139***a*, lower circumferential surface **145***b* abutting lower groove side wall surface **139***b*, upper core surface **144***c* abutting upper groove floor surface **129***c*, and upper circumferential core surface **144***d* abutting upper side wall surface **129***d*, in its maximum translation position of implant device **110**. In the rear translation depicted in FIG. **15**, lower core surfaces **145***g*, **145***h* slide into groove **138** and abut groove surfaces **139***g*, **139***h*, respectively, and upper core surfaces **144***e*, **144***f* slide into groove **128** and abut groove surfaces **129***e*, **129***f*, respectively, when implant **110** is in a maximum rear translation position.

Referring now to FIGS. **8***a* and **8***b*, upper plate **120** includes a pair of grooves **182***a*, **182***b* and lower plate **130** includes a pair of grooves **184***a*, **184***b*. The pairs of grooves **182***a*, **182***b*; **184***a*, **184***b* are dimensioned to accommodate the use of insertion tool **190** having upper protrusions **192***a*, **192***b* and lower protrusions **194***a*, **194***b* which engage upper grooves **182***a*, **182***b* and lower grooves **184***a*, **184***b*, respectively. The insertion tool **190** and in particular central raised portions **195***a* and **195***b*, with central ribs **196***a* and **196***b* maintain the implant device in a unified form during manipulation and insertion.

Referring generally now to FIGS. **16-26**, implant device **210** represents another form of an implant device in accordance with the present invention. Similar elements to those of devices **10**, **110** are similarly numbered by increase by 100 or 200, respectively.

Implant **210** includes an upper plate **220**, a lower plate **230** and a core element **240**. As with device **110**, anchors **223**, **233** are at a 45 degree angle relative to a major longitudinal plane through a midpoint of the implant device **210**. Thus, the relative angle of the anchors **223**, **233** provide for an antero-lateral approach for the insertion and implantation of the implant device **210**.

Unlike device **110**, lower convex surface **222** and upper convex surface **232** are formed in the lower and upper surfaces of the upper and lower plates **220**, **230**, respectively, rather than being convex surfaces of separate inlay elements.

FIGS. **16-20** depict the implant **210** in its neutral position whereby there is a circumferential grooves **228**, **238** formed around lower convex surface **222** and upper convex surface **232**, respectively.

FIGS. **21** and **22** depict left and right lateral bends, respectively, which are provided by implant **210** as a result of lower convex surface **222** articulating with upper concave surface **241** and upper convex portion **232** articulating with upper concave surface **242**. For example, during a left lateral bend (FIG. **21**), upper core surface **244***a* and lower core surface **245***a* slide into grooves **228**, **238**, respectively. In a maximum left lateral bend, core surfaces **244***a*, **245***a* abut groove surfaces **229***a*, **239***a*, respectively.

Similarly, during a right lateral bend (FIG. **22**), the upper plate **220** and lower plate **230** articulate along convex surfaces **222**, **232**. In a maximum right lateral bend, upper core surface **244***b* abuts upper groove surface **229***b* and lower core surface **245***b* abuts lower groove surface **239***b*, thus limiting lateral movement of upper plate **220** relative to lower plate **230**. As with the implant device **110**, limitation of movement is provided by the core surfaces **144**, **145** abutting groove surfaces **129**, **139**, respectively.

Referring now to FIGS. **23** and **24**, implant **210** provides for flexion and extension by having the articulating surfaces of the upper plate **220** and lower plate **230** slide along the abutting upper concave surface **241** and lower concave surface **242**, respectively, as depicted in FIGS. **23** and **24**, respectively.

Referring now to FIGS. **25** and **26**, left lateral translation and rear translation of the upper plate **220** with respect to the lower plate **230** are depicted, respectively. Translation of the upper plate **220** relative to the lower plate **230** is provided by the upper plate **220** moving in a lateral direction opposite that of the lower plate **230**. For example, during left lateral translation depicted in FIG. **25**, the upper plate **220** of implant **210** is translated in the direction of arrow **250** relative to the lower plate **230**, resulting in upper core surface **244***b* and lower core surface **245***a* being disposed in upper groove **228** and lower groove **238**, respectively. During the rear translation of the upper plate **220** of implant **210** in the direction of arrow **251** relative to the lower plate **230**, upper core surface **244***c* and lower core surface **245*d*** will be disposed in upper groove **228** and lower groove **238**, respectively.

FIGS. **27-31** show another embodiment **310** of an implant device in accordance with the present invention. Implant **310** differs from implants **110** and **210** by having upper and lower anchors **323**, **333** which are parallel to a transverse plane running through the major longitudinal axis of the implant device **310**. Like implant **10**, the parallel orientation of the anchors **323**, **333** with respect to the major longitudinal axis provides for a lateral insertion approach.

Further, like implant devices **10** and **210**, articulating convex surfaces **322**, **332** are formed on the lower and upper surfaces of upper plate **320**, lower plate **330**, respectively.

Like implants **110** and **210**, implant device **310** allows for limited universal movement via extension, flexion, left and right lateral bending, and translation with the limitation of movement provided by the interaction of core **340** with grooves **328**, **338**. FIGS. **27-29** depict the implant in a neutral position and FIGS. **30** and **31** depict the implant **310** in a translation position. The aforementioned limited universal movement and translation occurs in a manner similar to that described above with regard to implant devices **110**, **210**.

Referring now specifically to FIG. **29**, core **340** has a slightly broader concave surfaces **341**, **342**, i.e., a larger curvature radius, than the concave surfaces of cores **140**, **240**. As a result of the larger curvature radius of the concave surfaces **341**, **342** of core **340**, implant device **310** will have a larger degree of horizontal translation than implant devices **110**, **210**, while having the same degree of limited universal movement of lateral bending, flexion and extension as implant devices **110**, **210**.

The present implant devices provide features not present in other implant devices. For example, the present device provides enhanced relative movement between the upper part and lower part which includes translation of the upper part relative to the lower part. When implanted, the implant device of the present invention can provide natural movement of a patient's spinal column and movement between adjacent vertebrae where the implant device is inserted. The use of the present implant device with translation movement can be beneficial for implantation in patients with less severe degenerative disc disease and thus not require total disc replacement. In this instance, replacing only the nucleus pulposus of the intervertebral disc while leaving the disc annulus and the ligaments as intact as possible may benefit from the present implant device which provides limited translation movement. In one advantageous insertion technique, the intact ligaments provide the necessary support to accommodate the additional lateral and translational movement provided by the present implant device.

It will now be readily apparent to one of ordinary skill in the art that the present implant device provides advantages and features not shown in prior implants such as hydrogel/polymer nucleus replacement devices. For example, the present implant uses previously known materials which have been used in the field of arthroplasty. Further, the present implants allow for an initial secure and permanent fixation of the device using the anchors. Further, the present implants allow for the restoration of a normal nucleus movement which occurs during natural motion. In addition, the present implant allows for one to restore the natural disc height. Further, the present implant allows one to perform an adequate discectomy through a mini-open approach.

Although the invention has been described in considerable detail with respect to preferred embodiments thereof, it will be apparent that the invention is capable of numerous modifications and variations, apparent to those skilled in the art.

What is claimed is:

1. An intervertebral device for insertion between two adjacent vertebrae, comprising:

an upper part having an upper surface for engaging an upper vertebrae and a lower surface having a convex portion;

a lower part having a lower surface for engaging an adjacent, lower vertebrae and an upper surface having a convex portion; and

a core element having an upper concave portion to operatively engage with said convex portion of said upper part and a lower concave portion to operatively engage with said convex portion of said lower part,

wherein the upper and lower parts each have a groove located adjacent to and surrounding their respective convex portions, the groove having a groove floor surface adjacent the convex portion and a groove side wall surface located radially more distant from the convex portion than the groove floor surface and that extends from the groove floor surface toward the opposing part,

wherein the core element comprises an upper surface surrounding the upper concave portion, the upper surface terminating in a circumferential surface, and further comprises a lower surface surrounding the lower concave portion, the lower surface terminating in a circumferential surface, and

wherein the groove side wall surface of the upper and lower parts is constructed such that upon bringing the upper and lower parts together at an edge of the intervertebral device the terminal circumferential surface of the core element engages the groove side wall surface.

2. The intervertebral device of claim **1**, including a circumferential groove in the core adapted for receiving an insertion instrument.

3. The intervertebral device of claim **1**, wherein said upper part comprises an anchor for engaging a vertebrae.

4. The intervertebral device of claim **3**, wherein said anchor is at a 45 degree angle relative to a transverse longitudinal plane through a major axis of said device.

5. The intervertebral device of claim **3**, wherein said anchor is at an angle between 0 and 90 degrees relative to a transverse longitudinal plane through a major axis of said device.

6. The intervertebral device of claim **1**, wherein said upper part has an upper inlay element dimensioned to be disposed in a recess formed therein; said upper inlay element having a lower surface that includes the convex portion of the upper part and

said lower part has a lower inlay element dimensioned to be disposed in a recess formed therein; said lower inlay element having an upper surface that includes the convex surface portion of the lower part,

wherein said upper part and said lower part are translatable relative to each other by sliding along said concave portions of said core element.

7. The intervertebral device of claim **6**, wherein at least one of said upper part and said lower part comprises an anchor for engaging a vertebrae.

8. The intervertebral device of claim **6**, wherein said anchor is at an angle between 0 and 90 degrees relative to a transverse longitudinal plane through a major axis of said implant.

9. The intervertebral device of claim **8**, where said anchor is at a 45 degree angle relative to the transverse longitudinal plane.

10. The intervertebral device of claim **6**, wherein said core element comprises a circumferential groove adapted for receiving an insertion instrument.

11. The device of claim **6**, wherein each said inlay element is composed a material selected from the group consisting of metal, plastic and ceramic.

12. The device of claim **11**, wherein said plastic comprises polyethylene.

13. The device of claim **6**, wherein said upper groove has a groove floor surface at an angle relative to the horizontal; said lower groove has a groove floor surface at an angle relative to the horizontal; and said core element has upper angled surface and lower angled surface at respective angles in opposite directions to that of said upper groove floor surface and said lower groove floor surface, respectively.

14. The device of claim **13**, wherein said upper groove floor surface and said lower groove floor surface mate with said upper angled surface and lower angled surface of said core during maximum movement of said upper part relative to said lower part.

15. The device of claim **6**, wherein said upper groove has a groove floor surface parallel to the horizontal; said lower groove has a groove floor surface parallel to the horizontal; and said core element has upper angled surface and lower angled surface at respective angles sloping away from said upper groove floor surface and said lower groove floor surface, respectively.

16. The device of claim **15**, wherein said upper groove floor surface and said lower groove floor surface mate with said upper angled surface and lower angled surface of said core during maximum movement of said upper part relative to said lower part.

17. The device of claim **6**, wherein said upper part and said lower part remain parallel with respect to each other when said upper part and said lower part are laterally translated with respect to each other.

18. An intervertebral device for insertion between two adjacent vertebrae, comprising:

an upper part having an upper surface for engaging an upper vertebrae and a lower surface having a convex portion, the upper part having an upper groove located adjacent to and surrounding the convex portion, the upper groove having an upper groove floor surface located adjacent the convex portion and an upper groove side wall surface located radially more distant from the convex portion than the upper groove floor surface and extending vertically outward from the upper groove floor surface;

a lower part having a lower surface for engaging an adjacent lower vertebrae and an upper surface having a convex portion, the lower part having a lower groove located adjacent to and surrounding the convex portion, the lower groove having a lower groove floor surface located adjacent the convex portion and a lower groove side wall surface located radially more distant from the convex portion than the lower groove floor surface and extending vertically outward from the lower groove floor surface; and

a core element having an upper concave portion to operatively engage with said convex portion of said upper part and a lower concave portion to operatively engage with said convex portion of said lower part, the core element having upper and lower circumferential core surfaces surrounding and adjacent to the core concave portions, the upper and lower core surfaces terminating in a circumferential surface, whereby said upper part and said lower part are laterally translatable relative to each other by sliding along said concave portions of said core element, wherein the convex portion of the lower part is aligned with the convex portion of the upper part in one relative lateral position of the upper and lower parts, and at least a portion of said upper and lower core terminating circumferential surfaces abut at least a portion of the groove side wall surface of the upper and lower parts in a maximum bend position to the intervertebral device to limit movement of the upper and lower parts beyond the maximum bend position.

19. The device of claim **18**, wherein each said convex portion of said upper part and lower part comprise a surface of a respective inlay element dimensioned to be disposed in a respective recess formed in each of said upper part and said lower part.

20. The device of claim **19**, wherein said inlay element is composed a material selected from the group consisting of metal, plastic and ceramic.

21. The device of claim **20**, wherein said plastic comprises polyethylene.

22. The device of claim **18**, wherein:

said upper groove floor surface is at an angle relative to the horizontal;

said lower groove floor surface is at an angle relative to the horizontal; and

said upper and lower core surfaces are at angles in opposite directions to that of said upper groove floor surface and said lower groove floor surface, respectively.

23. The device of claim **22**, wherein said upper groove floor surface and said lower groove floor surface mate with said upper angled surface and lower angled surface of said core, respectively, during a maximum bend position of said upper part relative to said lower part.

24. The device of claim **18**, wherein said core element has an upper angled surface and a lower angled surface sloping away from groove floor surfaces of said upper groove and said lower groove, respectively.

25. The device of claim **24**, wherein said upper groove floor surface and said lower groove floor surface mate with said upper angled surface and lower angled surface of said core, respectively, during a maximum bend position of said upper part relative to said lower part.

26. The intervertebral device of claim **18**, wherein at least one of said upper part and said lower part comprises an anchor for engaging a vertebrae.

27. The intervertebral device of claim **26**, wherein said anchor is at an angle between 0 and 90 degrees relative to a transverse longitudinal plane through a major axis of said device.

28. The intervertebral device of claim **27**, wherein said anchor is at a 45 degree angle relative to the transverse longitudinal plane.

29. The intervertebral device of claim **18**, wherein said core element comprises a circumferential groove adapted for receiving an insertion instrument.

30. The device of claim **18**, wherein said upper part and said lower part remain parallel with respect to each other when said upper part and said lower part are laterally translated with respect to each other.

31. The intervertebral device of claim **18**, wherein the convex portion of the lower part is vertically aligned with the convex portion of the upper part in said one relative lateral position of the upper and lower parts.

32. The intervertebral device of claim **18**, wherein the groove side wall surface of the upper and lower parts is constructed such that upon bringing the upper and lower parts together at an edge of the intervertebral device the terminal circumferential surface of the core element engages the groove side wall surface.

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